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ELECTRON TUBE DIVISION
HARRISON NEW JERSEY

SECOND QUARTERLY PROGRESS REPORT
ON
PRODUCTION ENGINEERING MEASURE
FOR
TUBE TYPE 7587

DURING PERIOD OF:
1 SEPTEMBER 1962 TO 30 NOVEMBER 1962
CONTRACT NO. DA36-039-SC-86732
ORDER NO. 19054-PP-62-81-81

PEM & FACILITIES PROCUREMENT BRANCH
U.S. ARMY SIGNAL SUPPLY AGENCY
PHILADELPHIA 3, PENNSYLVANIA

PRODUCTION ENGINEERING MEASURE

for

TUBE TYPE 7587

SECOND QUARTERLY REPORT

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1 SEPTEMBER 1962 TO 30 NOVEMBER 1962

OBJECT

To provide critical facilities for high volume, low cost, production of Nuvistor tube types, with special emphasis on tube type 7587, by the development and construction of an automatic grid lathe, exhaust machine, and lead loader.

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W. Ackermann E. Rudolph

TABLE OF CONTENTS

		Page
I	Abstract	1
II	Purpose	2
III	Narrative and Data	3
	A. Grid Machine	4
	B. Exhaust Machine	8
	C. Lead Loader	11
	D. Table of Figures	17
IV	Conclusions	37
V	Program for Next Interval	38
VI	Publications and Reports	38
VII	Identification of Technicians	39

I. ABSTRACT

This second quarterly report contains a detailed account of the effort expended to date in implementing the first three phases of the contract during the subject period, as follows:

1. The translation of the equipment concepts conceived during the first quarter into practical working proto-types.

2. The evaluation and proof testing of the proto-types on a laboratory basis.

3. The reduction of the development results into practical designs.

4. The activation of actual equipment construction.

The report indicates that the basic development phase of all three tasks is complete, that the design phase is in process, and that the erection of the equipment has commenced. At the present rate of progress, it is anticipated that the design phase of all tasks will be completed near the end of the third quarter of the contract period.

II. PURPOSE

The purpose of this contract is to obtain high volume, low cost manufacturing capability for the Nuvistor tube type 7587 by the creation of several critical equipment facilities. It is an intent of this contract that the subject facilities inherently contain sufficient flexibility to not only service the tetrode line of Nuvistors, but also a broad spectrum of existing triode types and contemplated future types, such a long leaded Nuvistors.

The contract is divided into six phases; namely the development, design, construction, debugging, testing and evaluation of three main tasks:

(1) An automatic banded truss grid winding and brazing machine

(2) An automatic exhaust machine

(3) A semi-automatic lead loader

This effort not only involves the creation and construction of the subject facilities, but a complete in-production evaluation of equipment performance and product quality.

The contract has joint sponsorship, with the development, design and evaluation costs funded by the Army Signal Corps, and the construction costs funded by Radio Corporation of America.

III. NARRATIVE AND DATA

The second three month period of this contract involved the completion of the basic developmental phase of each task, the activation of the design phase of each task, and the commencement of the construction phase for the first two tasks. As a result, the basic design concepts for all tasks have been established, frozen, and reduced to practical equipment designs.

The following is a detailed account of the effort expended during this second quarter period, and the results obtained in each of the tasks. For each task, this account is divided into four areas;

1. A synopsis of the object of each task and the results obtained in the first quarter.

2. An account of the effort expended in the completion of the developmental phase of each task.

3. A description of the resulting equipment design for each task.

4. The status of equipment construction for each task.

A. BANDED TRUSS GRID WINDING MACHINE

1. SYNOPSIS

The purpose of this equipment is to produce a Nuvistor grid containing the feature of a truss, or strengthening, winding, by means of a continuous equipment process. The typical Nuvistor grid is a cylindrical structure composed of a large number of very fine axial control wires which are brazed to a spirally wound wrapping wire. This is conventionally accomplished by feeding braze resistant mandrels through a wire guide, which lays the axial wires on the mandrels, and subsequently through a winding head, which wraps the structure. In addition, the mandrels pass through a brazing furnace to join the wires rigidly. The present equipment performs this operation in an intermittant fashion, requiring the full time services of an operator to insert mandrels.

The proposed equipment will perform the same basic operation, however, in addition, the mandrels will pass through a second winding head, which will wrap a second winding on the structure at a relatively corse pitch. This winding, in conjunction with the primary winding, forms an array of triangular structures whose mechanical stability is similar to truss structures. Also, the machine will be capable of continuous operation, by virtue of a system of automatic mandrel storage and feed. Superimposed on the entire system is the requirement of "banding", or close-pitch winding, the primary winding in certain areas of each grid, to provide additional rigidity, without varying the pitch of the truss winding.

The first quarter effort was primarily directed towards developing (a), a suitable mandrel storage and feed system, (b), a roll feed for driving the mandrels through the winding heads, and (c), a

1. SYNOPSIS (CONT'D)

practical method for varying the pitch of the primary winding while maintaining the truss pitch constant. During that period, a vertical magazine was developed which proved highly successful, but had the disadvantage of being a vertical system tied to a basically horizontal feed machine. Thus, effort was concentrated on a horizontal magazine of equal reliability, and that effort continued into the second quarter. Also, a study was made of various roll feed systems which would be capable of continuously feeding mandrels with stable registry and yet provide for banding. This study also continued into the second quarter.

2. DEVELOPMENT PHASE

During this second quarter period, the development phase of this task was completed in all respects. First, a horizontal magazine feed system has been developed, and a model constructed as shown in figure 1. As shown in figure 2, the mandrels are loaded between two pairs of vertical guides and stacked one above the other. Two rotating rollers are located at the lower end of the guides, which tend to drive the bottom mandrel out of the magazine. Basically, the system is simple, but considerable jamming occurred until the rear roller was replaced with a square piece. As a result, the rear end of the mandrel stack oscillates vertically and this action prevents sticking of the mandrels in the guides. It should also be noted that the guides are near the ends of the mandrel stack, thus allowing for cambered mandrels.

The second development area concerned the method for feeding the mandrel with rolls and simultaneously varying the rate of feed to produce primary wire "bands" without changing the truss wire pitch.

2. <u>DEVELOPMENT PHASE (CONT'D)</u>

Of the three possibilities shown in the first quarter report, a study showed that all possessed an equal degree of accuracy. The problem was then reduced to a matter of determining the most economical and straight foward method. As shown in figure 3, a worm and wheel system was chosen as a primary drive. In order to obtain banding, it was decided to mount the entire roll feed on a platform which would be oscillated back and forth with a cam drive, to achieve banding, as shown in figure 4. Thus, if the rolls feed mandrels at a uniform rate, the cam motion will be alternately additive and subtractive and will effectively vary the mandrel feed rate in a very precise manner with absolute repeatibility. In addition, in order to obtain a uniform truss winding, the truss winding head is mounted on the same platform so that the relative motion of the mandrel with respect to the head is a fixed value.

Referring again to figure 3, it should be noted that the worm and wheel drive is so designed to allow the rolls to move laterally to accomodate various mandrel diameters. This feature also allows the rolls to center themselves on the mandrel without imparting any lateral forces.

On the basis of excellent results with the model magazine feed and the simplicity of the roll feed concept, the development phase was closed and design commenced.

3. <u>DESIGN PHASE</u>

The design phase of this task was initiated early in this quarter, with first consideration given to a practical means of supporting an oscillating platform mounted with the roll drive and truss head. Various layouts were made employing different types

3. DESIGN PHASE (CONT'D)

of conventional slides, such as dovetail, roller, and bushing systems. All of these arrangements were workable schemes, but involved rather massive structures, along with the usual problems of wear and possible sticking. Since the oscillating motion required is of a small magnitude, any erratic action is difficult to detect, and probably would only become apparant in the final product. Thus, it was decided to mount the entire platform on four cantilevered leaf springs, as shown in figure 5. As the cam oscillates the platform, the leaf springs bend, maintaining the system in a parallel plane. Since the cam motion is small, the resultant vertical motion due to spring bending is insignificant. This concept offers a friction free system which cannot wear or stick, and is far simpler and inexpensive. On this basis, the machine design has progressed to approximately the 30% point, with layout and detail work progressing simultaneously.

4. CONSTRUCTION PHASE

Approximately 20% of the dollar value of the equipment was released to the shop for construction during the month of November and fabrication has been started on the primary winding head.

B. EXHAUST MACHINE

1. SYNOPSIS

The purpose of this equipment is to evacuate and seal Nuvistors by a semi-batch technique at practical production rates. The prime objective is to assure that each tube is exposed to a precisely defined environment, and that this environment remains constant over long periods of time. The process consists of pumping a series of chambers, containing Nuvistors, to a very low pressure ($10^{-[illegible]}$ mm Hg), heating the product to drive out absorbed gases, then raising the product temperature sufficiently to melt a seal brazing ring, and finally cooling the system for subsequent removal of product.

During the first quarter, the major effort was expended in three areas:

(a) Development of a suitable chamber design.

(b) Development of a thermal power supply capable of precise temperature control and programming.

(c) Determination of a practical overall machine configuration.

During that period, a head design was conceived, as outlined in the first quarterly report, and two versions were released to the shop for construction. Both heads were similar except for overall length, with the shorter version destined for life tests on existing exhaust equipment, and the longer unit designed for qualitative measurements on an experimental basis.

A preliminary design was established for the power supply, based upon a saturable core reactor system

1. SYNOPSIS (CONT'D)

sensitive to load voltage, and plans were laid to construct a proto-type unit for evaluation.

Finally, the overall machine layout was frozen to include a Vacuum Electronics Corporation pumping system #VS401 with a sixteen head manifold system mounted above.

2. DEVELOPMENT PHASE

During this second quarter period, the head life test was completed and the thermal power supply was evaluated and finalized. A proto-type head was constructed, as shown in figure 6, and mounted on an existing Nuvistor exhaust facility. Upon activation, this head displayed a considerably higher operating temperature than the conventional heads, at identical power input. Series resistance was tied to the head to bring it within operating limits, and the unit has been in production for approximately 1½ months. It appears that this head exhibits approximately a 30% higher thermal efficiency, due primarily to improved radiation shielding.

An experimental saturable core reactor system was assembled and tied to a dummy load. The unit consisted of a voltage detector, amplifier, reactor, and load which in combination, act as a servo-mechanism to sense output voltage and control input power to maintain constant output power, regardless of load fluctuations. This basic system suffered from "hunting" or oscillation when the load value was rapidly varied. It was found that the servo loop had a low response time, and thus tended to overshoot during transient load conditions. As a result, several changes were made in the choice of commercial components and these were modified to increase the damping factor of the system. Figure 7 illustrates, in block form, the basic system and its function in the exhaust machine.

3. DESIGN PHASE

During this quarter, the design of the basic machine was completed and released to the shop for construction. Upon completion of construction, the second proto-type head will be mounted on the manifold and qualitatively tested for pressure and temperature stability during operation. Upon completion of tests, the final head design will be established.

The basic machine consists of a pumping unit side-by-side with a power supply cabinet. A sixteen head manifold is mounted on top of the cabinets along with power busses and cooling water supplies. The control system contains both time and temperature program controls that are variable in a stepless fashion. The entire process cycle is automatic and requires only one push button to activate.

4. CONSTRUCTION PHASE

Figure 8 shows the status of construction of the exhaust machine as of the end of this reporting period. Mechanical construction is nearing completion and electrical assembly of the power supply is pending delivery of several commercial units.

C. LEAD LOADER

1. SYNOPSIS

The purpose of this facility is two-fold, as follows:

a. Cut nine molybdenum wire leads from spooled wire and feed them through the base wafer holes so as to serve as both internal structural supports and connectors for the several electrodes composing a Nuvistor.

b. Provide an individual copper ring to each lead (including two previously loaded heater leads) to serve as the source of braze media for the lead to wafer seals.

As outlined in the previous reporting period, the basic concepts of lead loading were formulated during the early stages of the Nuvistor development, and tested in a proto-type unit designed for triode manufacture. The principles developed in this previous endeavor have been modified and applied to the design of a mechanized lead loader for the tube type 7587 during the first quarter period.

The far more difficult operation of supplying copper braze washers to each of the leads has required the application of a major portion of the development effort associated with this task. During the first quarter, two alternative concepts were formulated to achieve the required results:

a. Attaching copper rings to the base wafer, concentric with each lead hole, prior to lead loading.

b. Threading individual copper rings over the leads after lead loading.

1. SYNOPSIS (CONT'D)

As a result, an evaluation program was initiated for both methods by construction of proto-type devices simulating proposed production equipment. The first concept was tested by means of a die which pierced and blanked a copper ring from strip stock and pressed it against the wafer surface with sufficient force to cause adherence due to extrusion of copper into the surface pores of the wafer. Various strip tempers were tested, and full hard copper proved to provide maximum adherence. However, in the act of pressing the rings, the copper exhibited a considerable tendency to flow radially and partially obstruct the lead holes. At the end of the first quarter, plans were laid to obstruct this inward flow by means of spring loaded pins within the punches of the die.

The second concept was initially evaluated by means of two dies; the first, which simultaneously pierced a hole and formed a conical impression in strip stock, and the second, which blanked the conical shape from the strip and dropped it onto a pre-located lead in a base wafer. On this basis, it was projected that a rotary indexing machine could feed pre-brazed Nuvistors assemblies, loaded in conventional brazing jigs, past two blanking dies that would thread the copper rings first over the long connector leads and then over the stub support leads. Since the long leads require guidance and location during the process, a suitable experimental gathering "comb" was designed and released for construction. Near the end of the first quarter, the experimental dies and comb were completed, and preliminary tests indicated that the process was a practical method which required further development to solve one major problem; reliable parting of the washers from the blanking punches.

2. DEVELOPMENT PHASE

The development phase of the copper pressing technique was completed during the second quarter period, and figure 9 shows a general view of the experimental die used in evaluating this method. In an attempt to prevent the radial inward flow of the copper from obstructing the lead holes, the punches were drilled out to accept spring loaded pins whose ends were tapered to close the hole openings completely, as shown in figure 10a. Of necessity, a 0.002 inch radial clearance was provided between the pins and holes in the punches to accomodate the manufacturing tolerances of wafer hole location. As shown in figure 10b, the pins very effectively blocked the flow of copper into the holes, but it extruded very readily up into the pin-punch clearance, resulting in a circular flash which subsequently would surely be accidently deformed in normal wafer handling procedures. As a next development step, the tapered pins were replaced with flat pins which were fitted to the punches with only a 0.0002 inch radial clearance, in the anticipation that neither a flash nor radial flow under the pins would occur. As before, the radial flow was effectively blocked, but the copper extruded up into the very small clearance, leaving a more fragile flash, as shown in figure 11.

Overshadowing the entire washer pressing development was a very definite reduction in washer adherence when blocking pins were employed, as compared to plain punches. Subsequent examination of sectioned samples revealed that when inward radial flow was blocked, the outward flow reached a magnitude which sheared the minute extrusions of copper in the wafer pores from the washer proper. Attempts to contain the outward flow resulted in increased flash in the pin-punch clearance and a second flash in the punch-die clearance.

2. <u>DEVELOPMENT PHASE (CONT'D)</u>

The results of this development led to a conclusion that the pressing technique, depending on adherence of copper directly to ceramic, is an unreliable and impractical method of supplying lead seal brazing material. This does not preclude the possibility of employing an intermediate layer of material between the copper washer and the wafer as a means of obtaining adherence; however, this concept requires the development a material having non-contaminating properties, good adherence under pressure and lack of adherence prior to the application of pressure. Presently, a preliminary survey of various nitrocellulous compounds is being conducted to determine their possible application to the problem.

On the other hand, the development of the alternate washer threading method was brought to completion during this second quarter period. At the end of the first quarter, a two hole pierce and cone-form die, (figure 12) a one hole blank and thread die, (figure 13) and a long lead gathering comb (figure 14) had been completed. First tests indicated that the conical washer blanks adhered to the punch of the threading die and plans were initiated to drill out the punch and inject air to strip the blank. This was accomplished, and repeated tests indicated that the air eject operated with satisfactory reliability. As a result, design proceded on an eleven hole strip pierce and form die (figure 15) and a five hole threading die (figure 16) to fully test the process. The pierce and form die was fabricated with a full compliment of punches so that it could also be utilized as a final production unit. The five hole threading die was fabricated to test the loading of the five long lead washers simultaneously. Proof tests indicated that the pierced blanks did not reliably "pop" from the strip in the form die, as shown in figure 17a, and as a result, this die is

2. DEVELOPMENT PHASE (CONT'D)

undergoing a minor modification, as shown in figure 17b, to eliminate this condition. It was also discovered that the air eject in the five hole threading die operated properly at first, but as soon as imperceptable wear took place on the punch edges, the eject became unreliable. As a result, this die is undergoing modification, by the addition of hollow spring pins inside of the punches as shown in figure 18, which will accomplish positive stripping. However, the tests generally indicated that the threading process is entirely feasible and several dozen samples verified this conclusion. A sample of the results is shown in figure 14 prior to removal of the gathering comb. This latter item consists of a series of slots with vacuum ports at each apex, which serves to locate the long leads accurately during threading.

On the basis of the tests, the development phase was concluded (except for modifying the dies)and design proceeded towards the completion of a mechanized lead loader and copper washer threading machine.

3. DESIGN PHASE

The design of a mechanized lead loading unit and an automatic copper washer threading machine commenced in late November.

The lead loader will automatically feed nine leads, cut them to the various required length, and drop them through the wafer holes, similar to the proto-type machine described in the first quarter report. The wafers will come to the unit already loaded in the brazing jigs, along with the electrodes, heater, and heater leads. One operator will load and unload the assemblies, and inspect the product.

3. <u>DESIGN PHASE (CONT'D)</u>

The washer threading machine will make and thread eleven washers over the eleven tube leads (including the heater leads) in two operations:

(a) long leads with a comb for lead location.

(b) short (stub) leads without a comb.

An operator will load the lead loaded brazing jigs onto a conveyor, which will carry the assemblies, one by one, into an indexing turret. The turret will position a typical jig under the first threading die. The turret will contain long lead location combs, one for each turret position. The first die will blank the long lead washers from pre-punched strip stock, and these washers will drop down the leads to rest on the comb. The assembly will then be positioned under the second die, which will move down until the ends of the long leads are engaged in clearance holes in the die plate. The comb will then retract, allowing the previously threaded washers to drop to the wafer, and the die will continue moving down until the stub leads are almost engaged. The remaining washers will then be blanked and dropped onto the stub leads. Finally, the assembly will be automatically unloaded, ready for brazing.

Rough layouts of all the major mechanisms have been completed, and the final design and details are in process. Specifications are being compiled for the purchase of a commercial turret indexing unit, and will be released for bid in December.

4. <u>CONSTRUCTION PHASE</u>

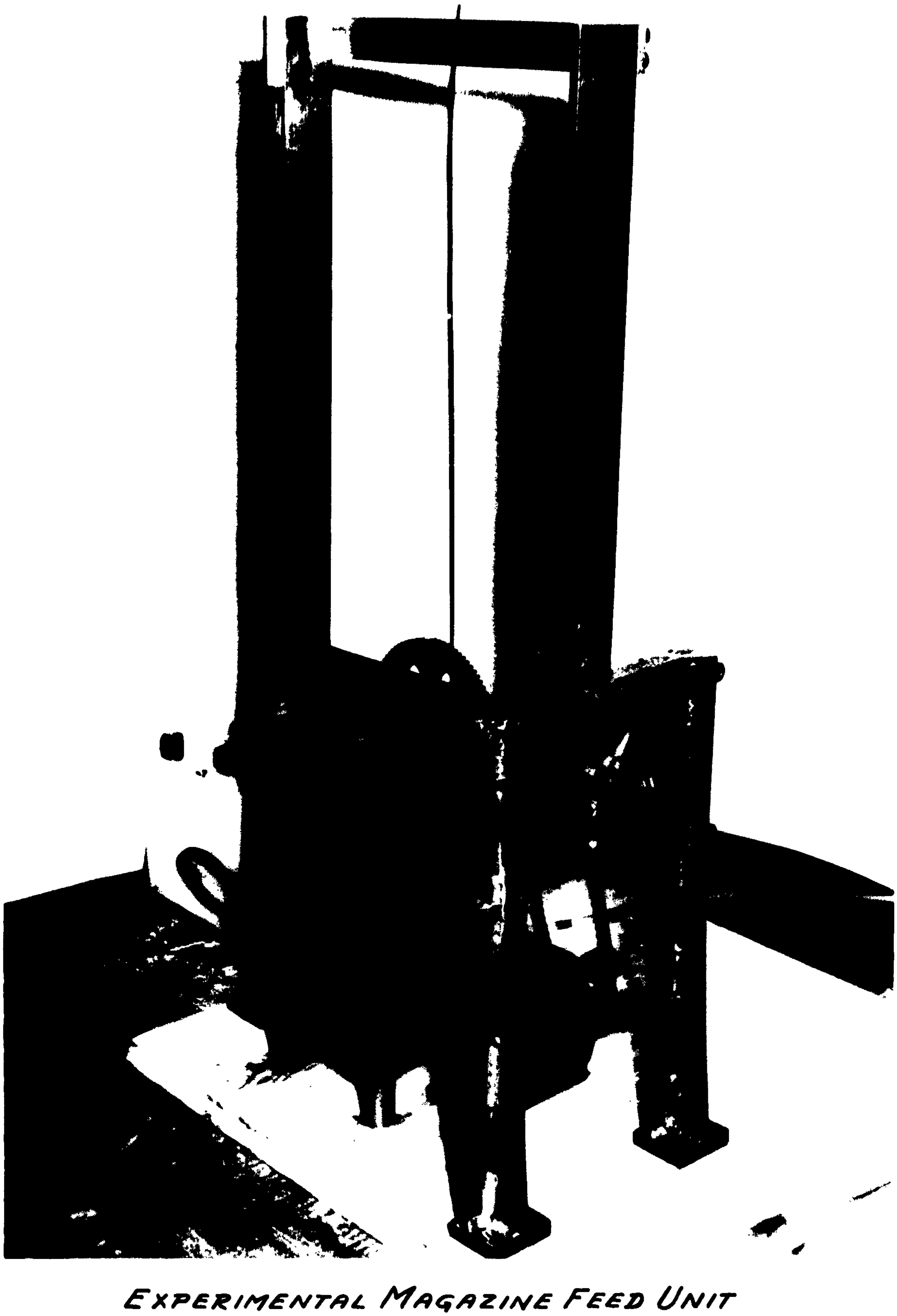
This phase will commence in December.

D. TABLE OF FIGURES

Figure	Title	Page
1.	Photograph of Experimental Magazine Feed Unit	19
2.	Schematic of Magazine Feed Unit	20
3.	Schematic of Roll Feed Unit	21
4.	Schematic of General Grid Lathe	22
5.	Schematic of Platform Suspension	23
6.	Photograph of Pilot Exhaust Head	24
7.	Schematic of Exhaust Machine Power Supply	25
8.	Photograph of Exhaust Machine (construction to date)	26
9.	Photograph of Washer Pressing Die	27
10.	a. Schematic of Pressing Die with tapered blocking pins	28
	b. Schematic of Washer after pressing	
11.	Schematic of Washer after Pressing with flat blocking pins	29
12.	Photograph of two hole pierce and cone-form die	30
13.	Photograph of one hole threading die	31
14.	Photograph of comb assembly showing an inserted jig after threading	32

D. TABLE OF FIGURES (CONT'D)

Figure	Title	Page
15.	Photograph of eleven hole pierce and cone-form die	33
16.	Photograph of five hole threading die	34
17.	Schematic of forming die showing: a. Unsuccessful piercing b. Inserted Bushings to assure piercing	35
18.	Schematic showing hollow spring ejector pins in threading die punches	36



EXPERIMENTAL MAGAZINE FEED UNIT

FIG. 1

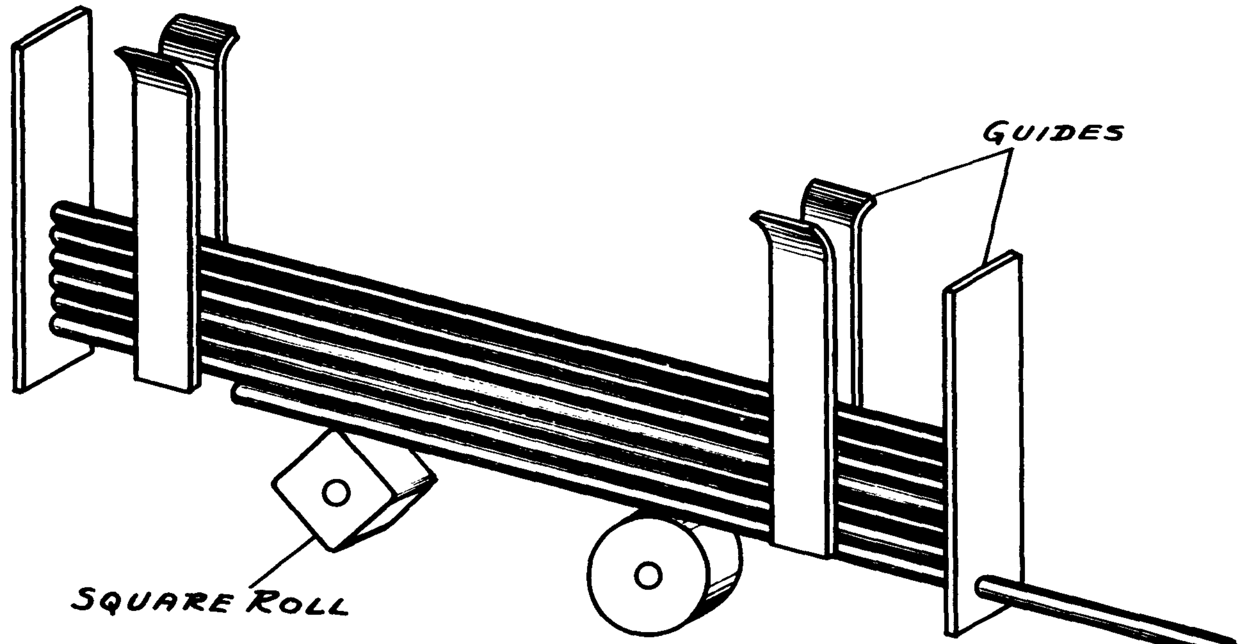


FIG. 2 SCHEMATIC OF MAGAZINE FEED UNIT

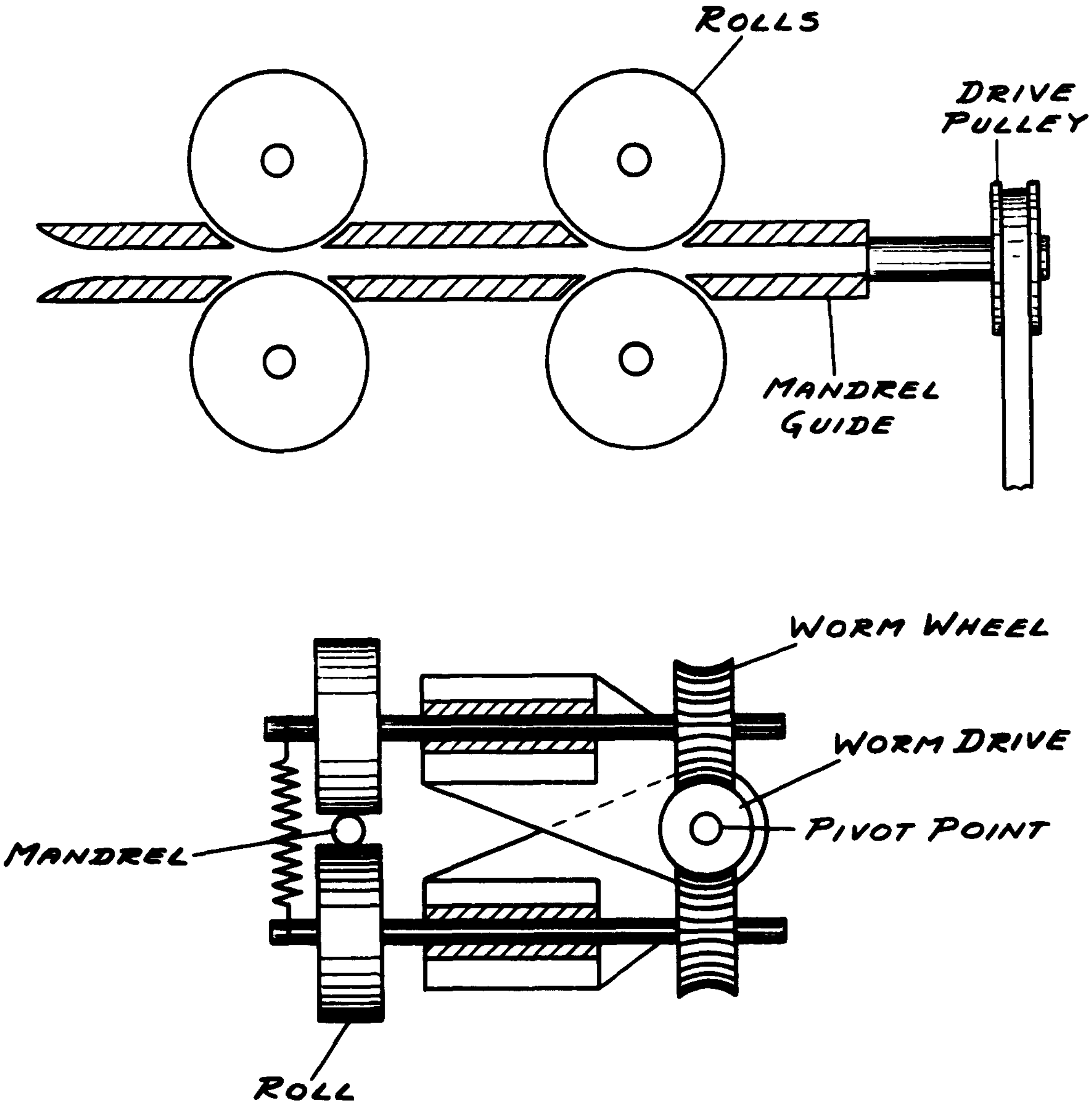


FIG. 3 SCHEMATIC OF ROLL FEED SYSTEM

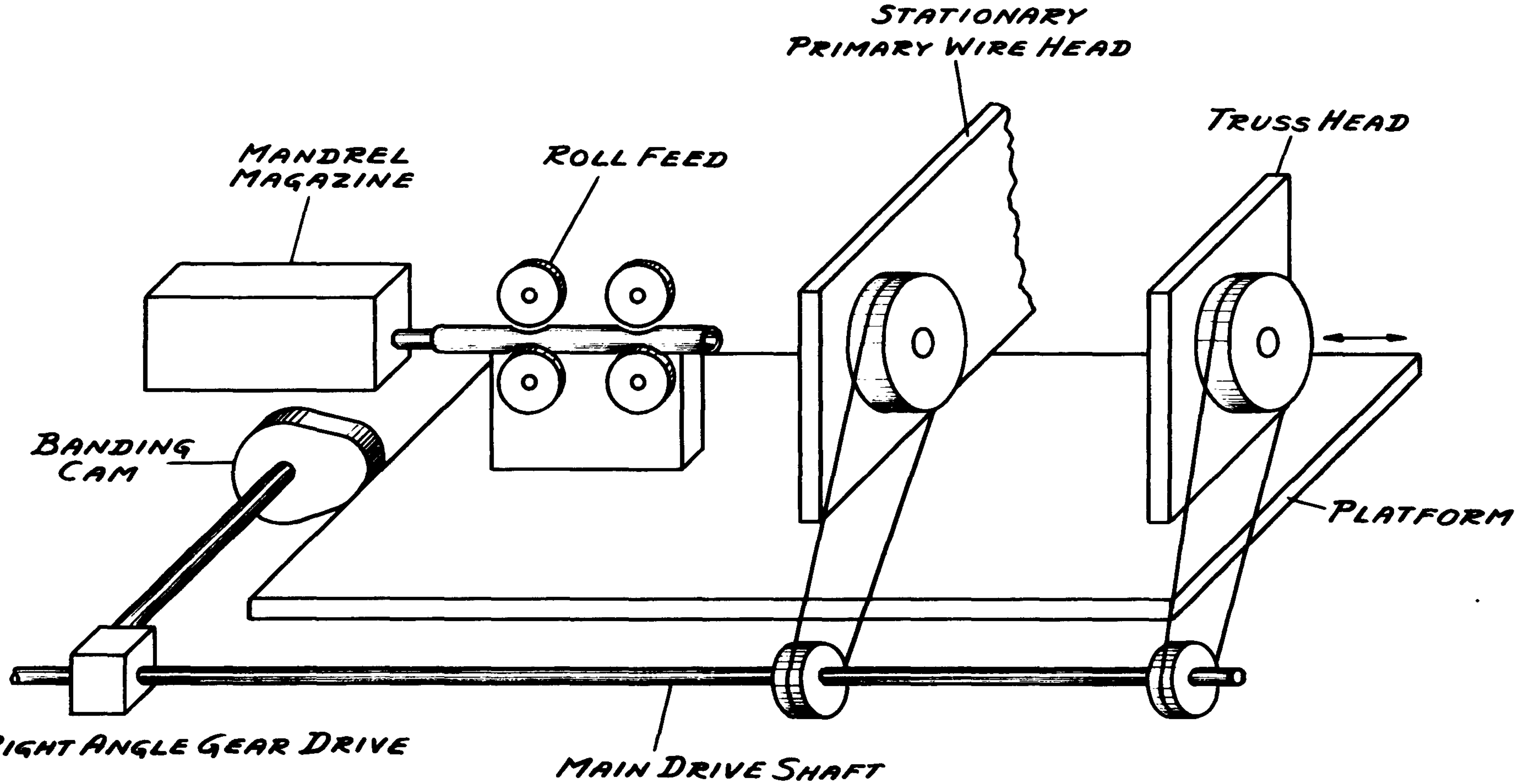


FIG. 4 SCHEMATIC OF PLATFORM SYSTEM

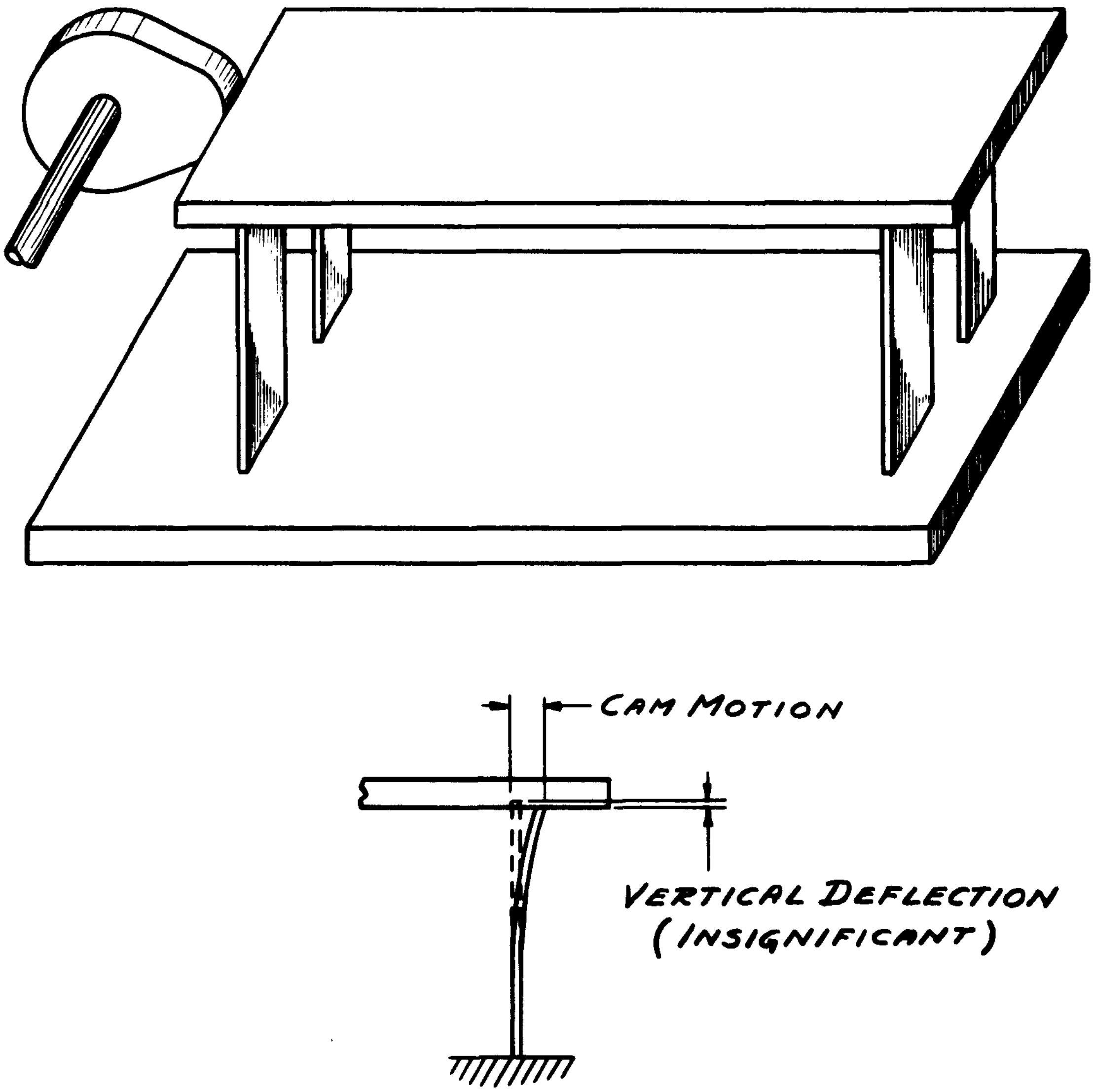


FIG. 5 LEAF SPRING SUPPORT SYSTEM

PILOT EXHAUST HEAD

FIG. 6

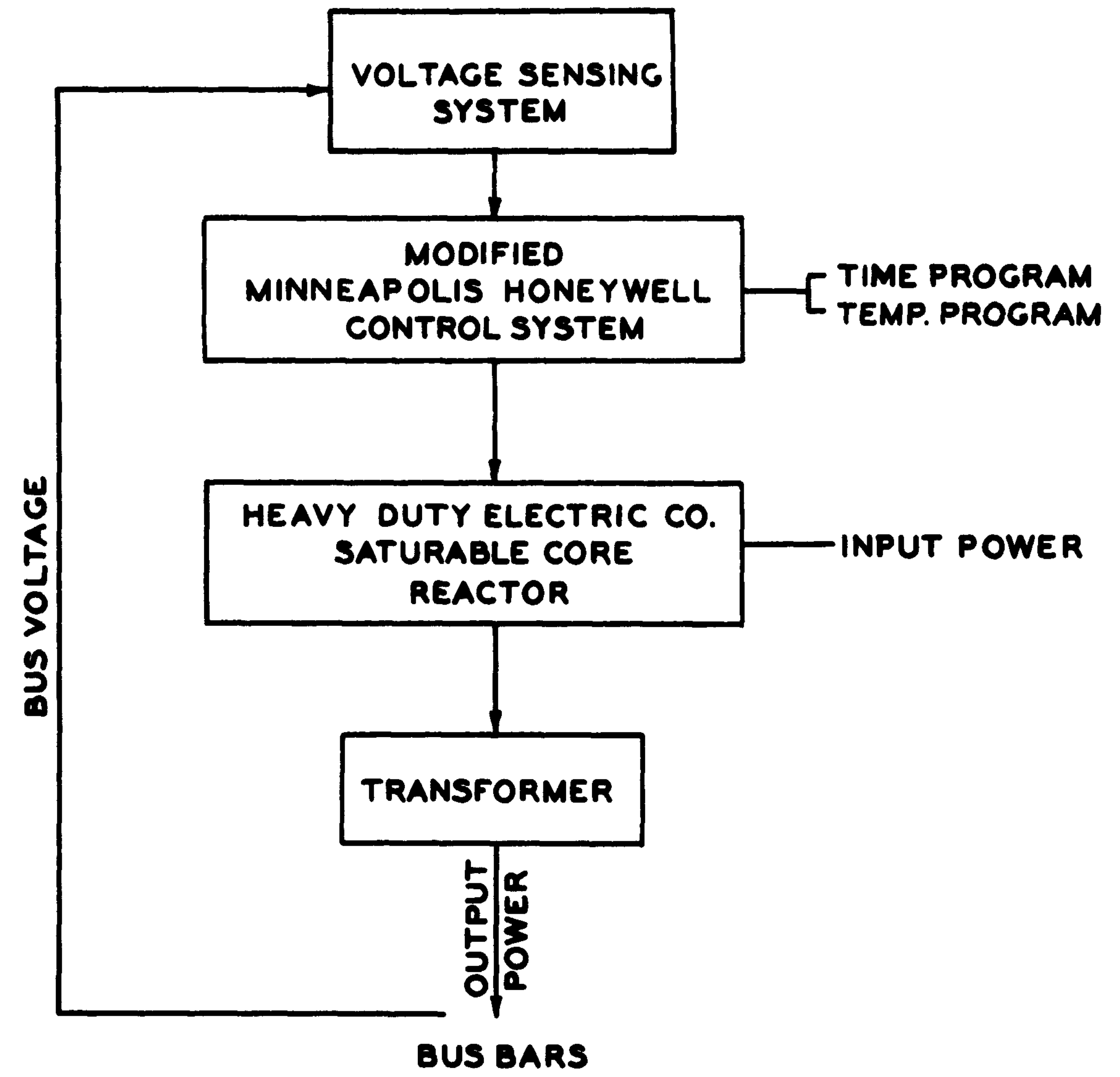
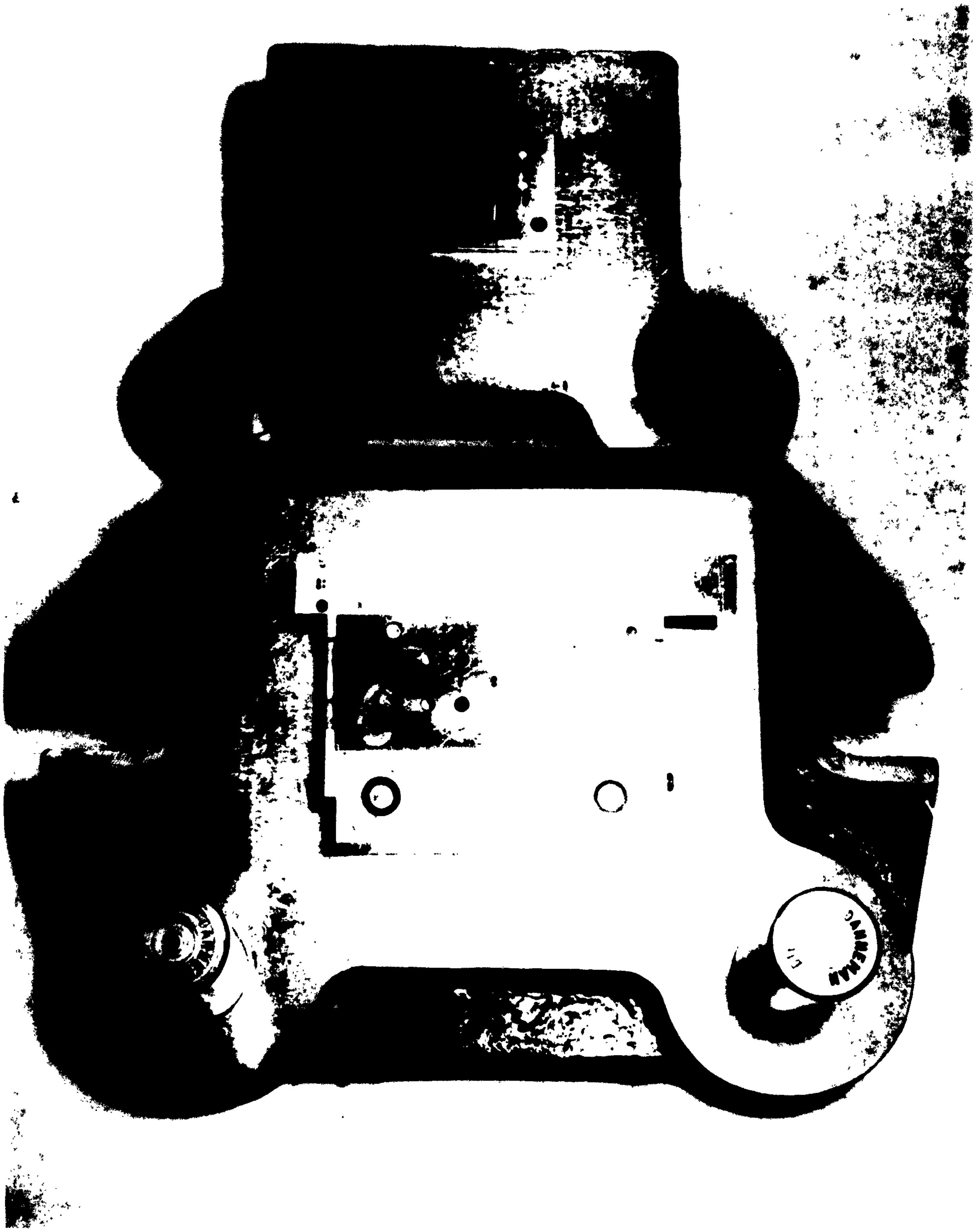


FIG. 7 BLOCK DIAGRAM OF THERMAL POWER SUPPLY

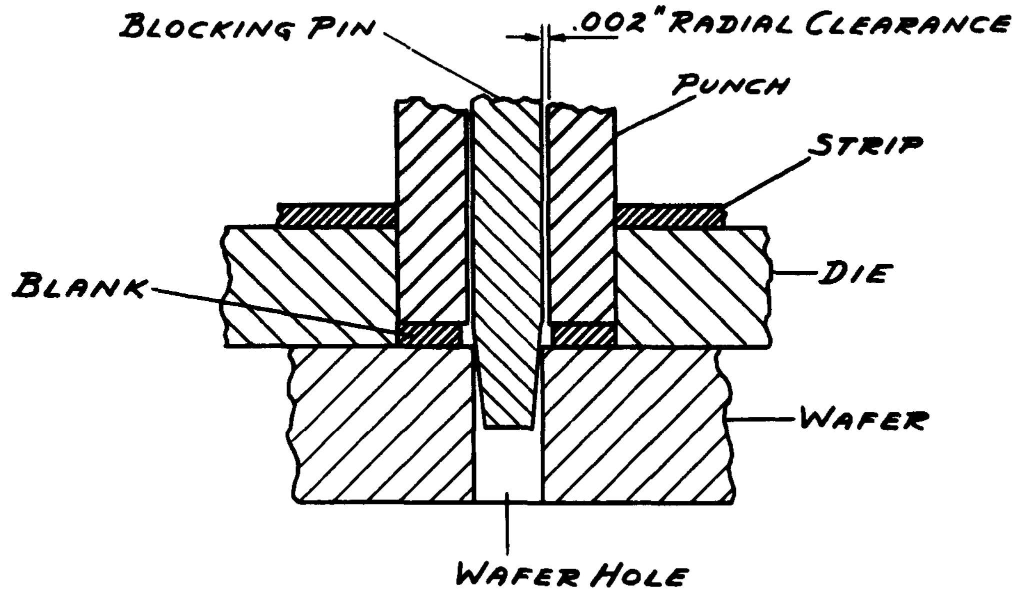
EXHAUST MACHINE

FIG. 8

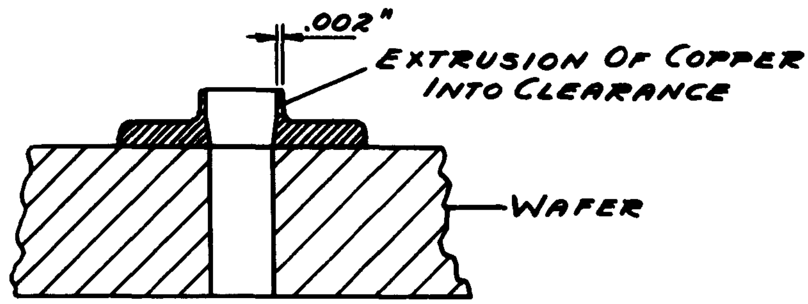


WASHER PRESSING DIE

FIG. 9

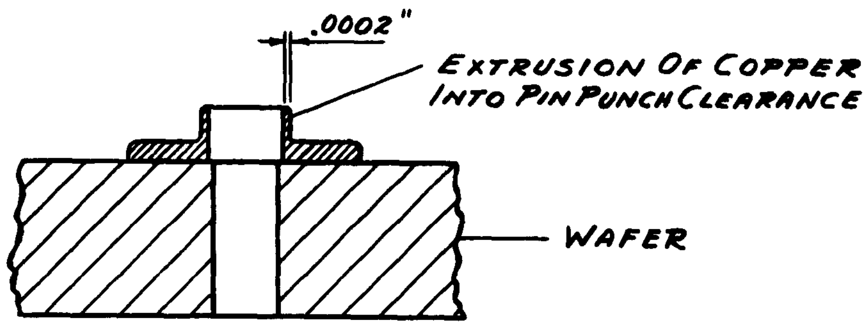


(a) SCHEMATIC OF PRESSING DIE WITH TAPERED BLOCKING PINS



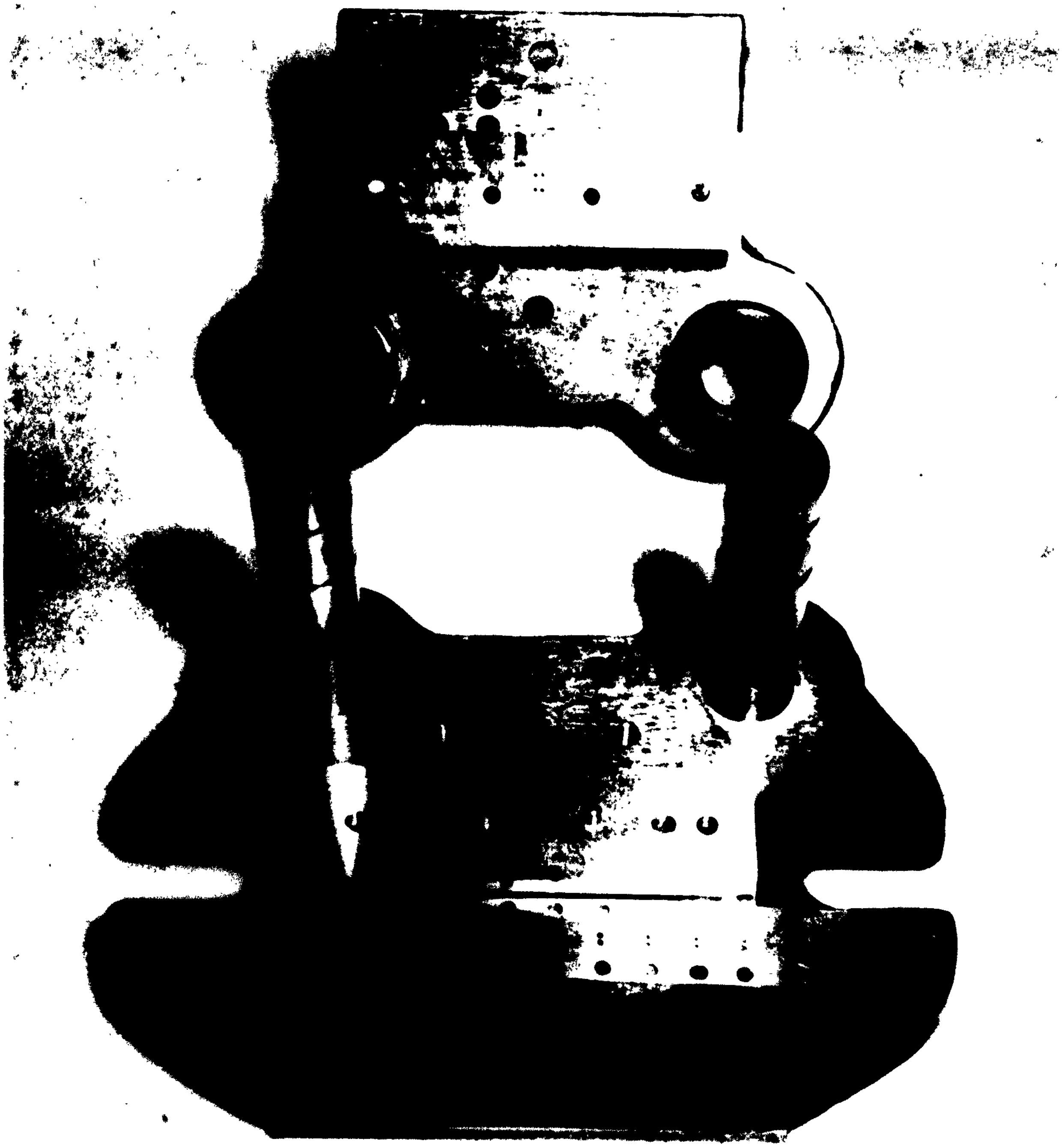
(b) SCHEMATIC OF WASHER AFTER PRESSING

FIG. 10



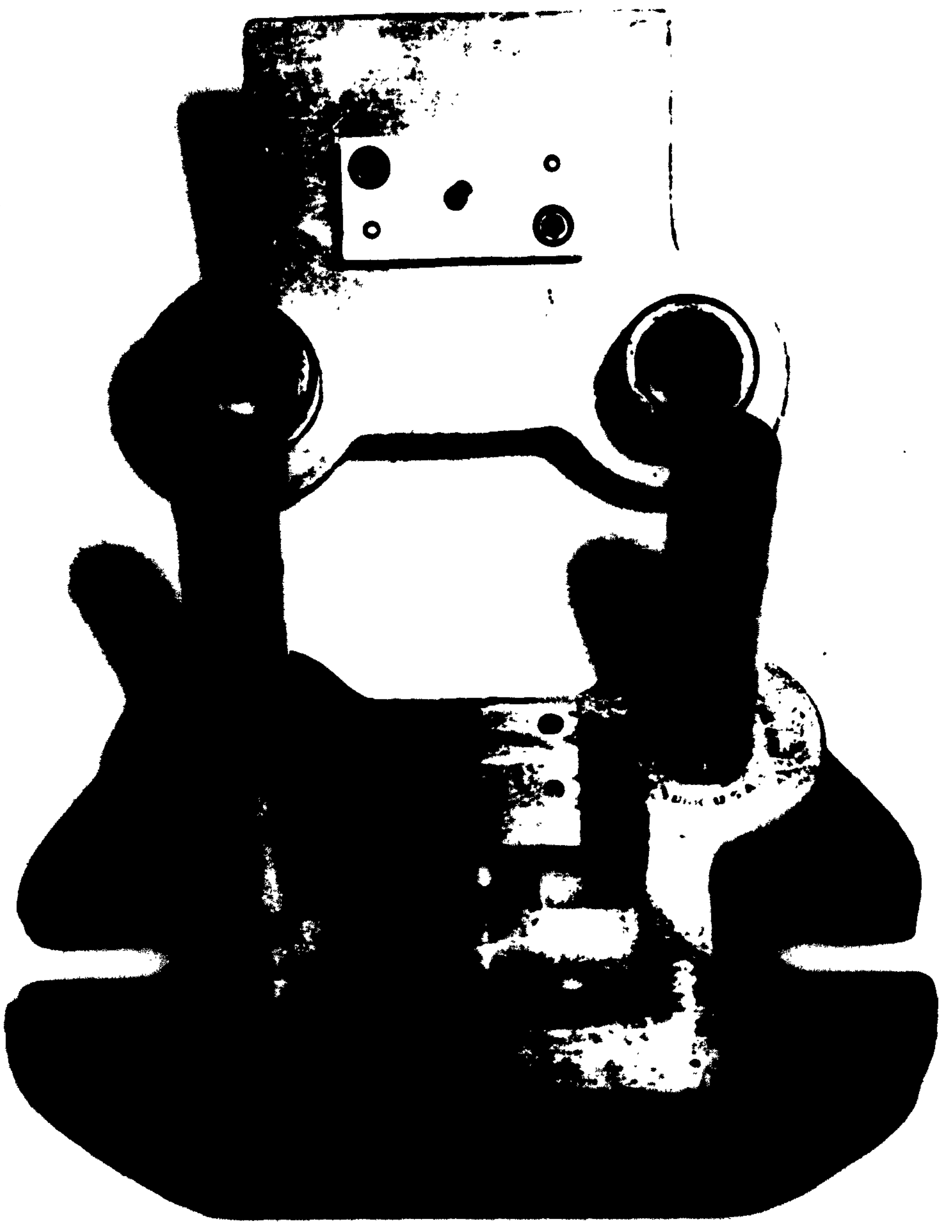
SCHEMATIC OF WASHER AFTER PRESSING
WITH FLAT BLOCKING PINS

FIG. 11



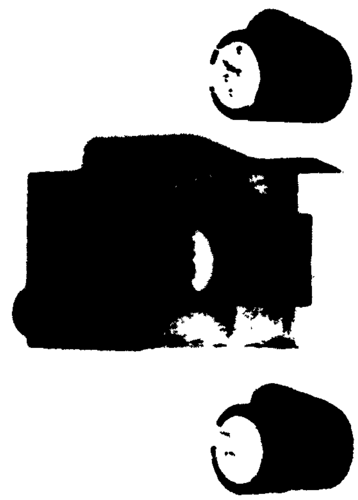
TWO HOLE PIERCE AND FORM DIE

FIG. 12



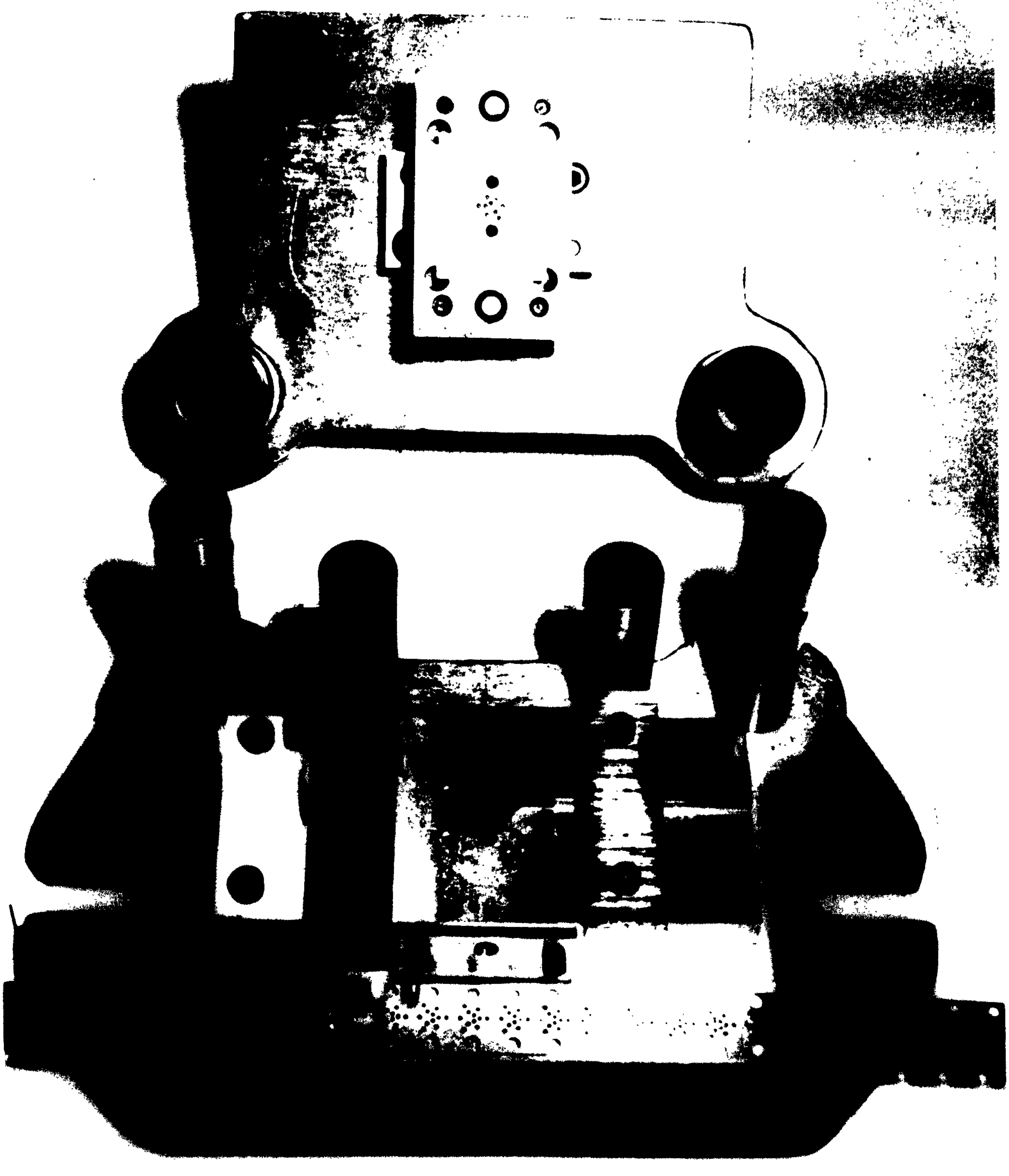
ONE HOLE THREADING DIE

FIG. 13



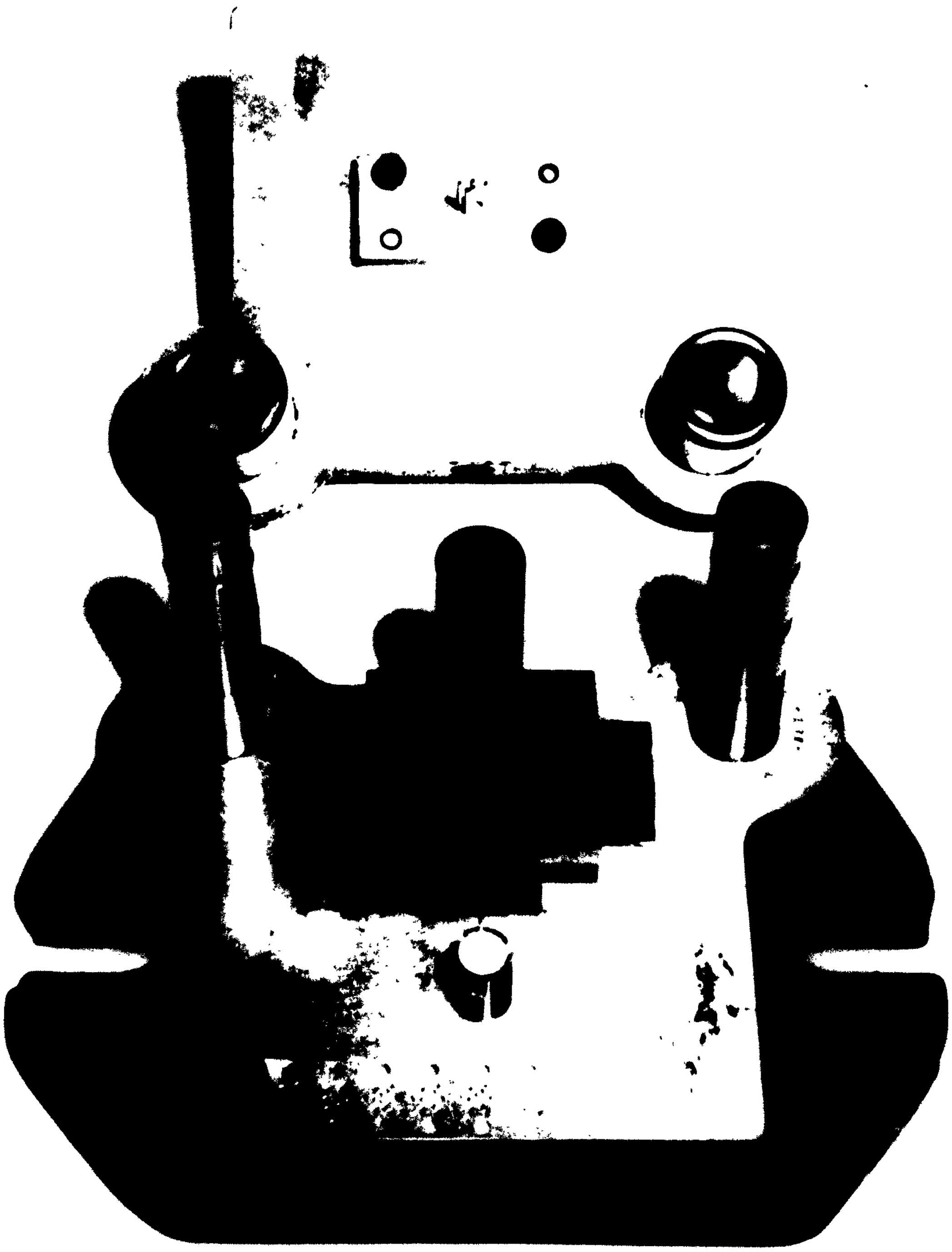
COMB ASSEMBLY SHOWING INSERTED JIG AFTER THREADING

FIG. 14



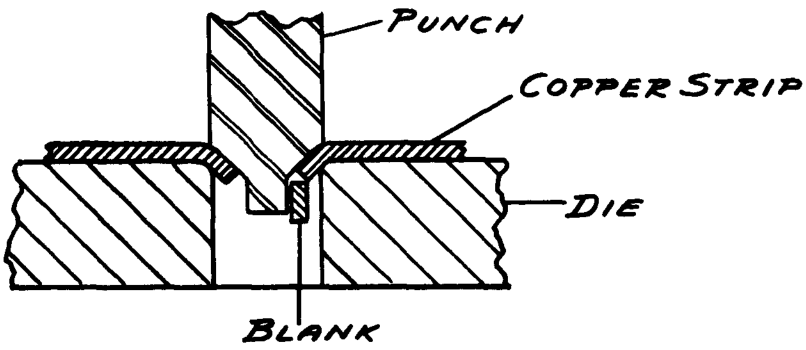
ELEVEN HOLE PIERCE AND CONE-FORM DIE

FIG. 15

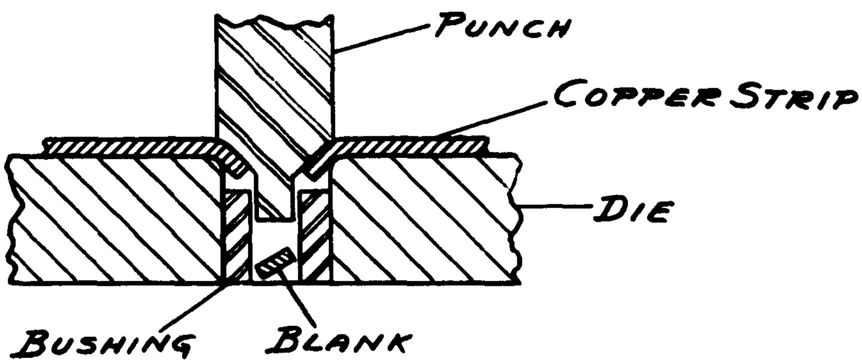


FIVE HOLE THREADING DIE

FIG. 16

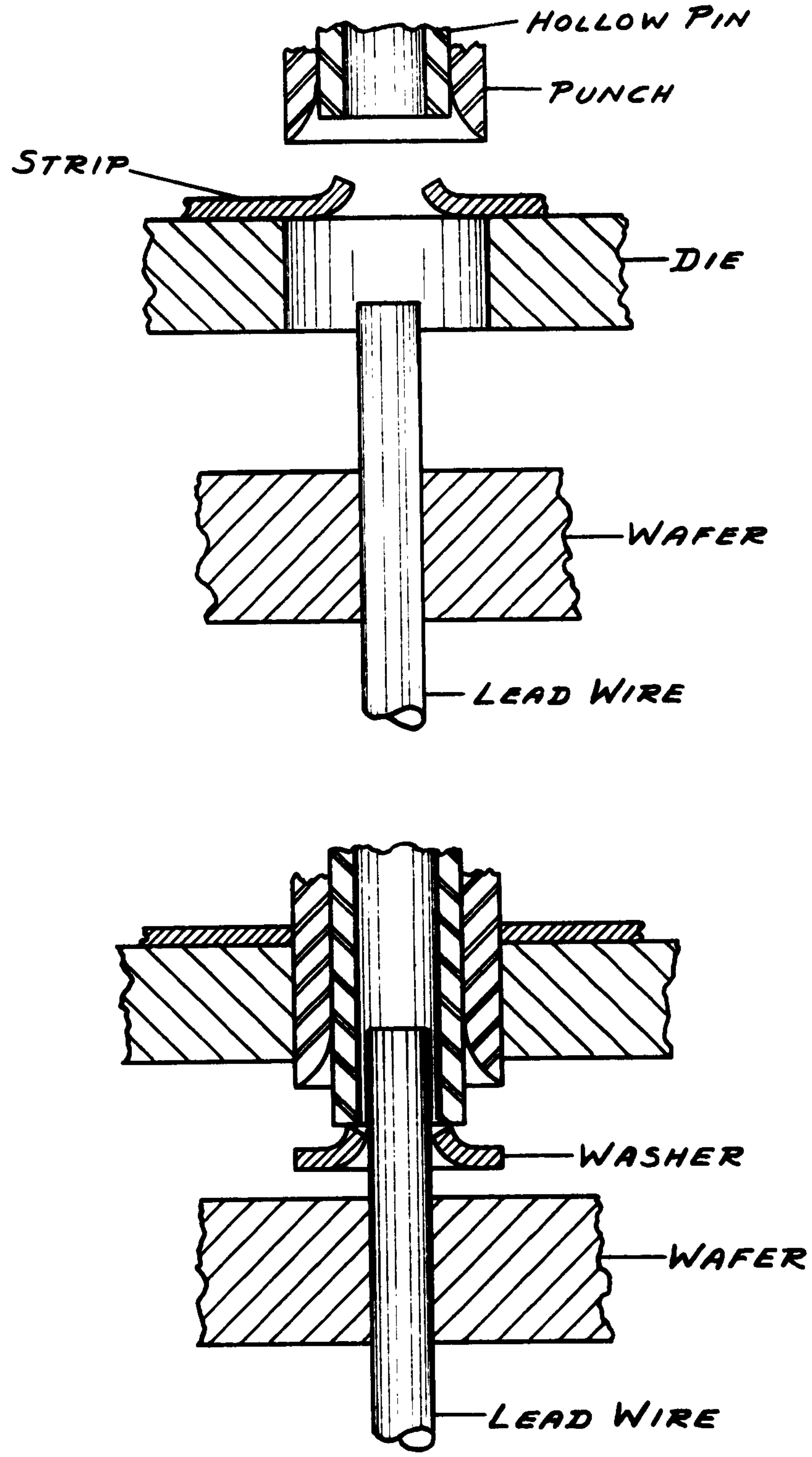


(a) SCHEMATIC OF FORMING DIE SHOWING AN UNSUCCESSFUL PIERCING



(b) INSERTED BUSHING TO ASSURE PIERCING

FIG. 17



SCHEMATIC SHOWING HOLLOW SPRING EJECTOR PINS IN THREADING DIE PUNCHES

FIG. 18

IV. CONCLUSIONS

A. TRUSS GRID WINDING MACHINE

The development phase is completed, with the evolution of an acceptable horizontal mandrel magazine and roll feed system. The concepts have been fully proof tested and the overall design has been frozen. Actual machine design is 30% complete and 20% of the dollar value of the equipment has been released for construction.

B. EXHAUST MACHINE

The exhaust head design has been life tested in actual production conditions and exhibits a superior thermal efficiency, as compared to conventional units. The basic machine design is complete and equipment fabrication is 60% complete. A second pilot head is ready for qualitative temperature and pressure evaluation and will be tested during the next quarter, using the final pumping and power supply systems.

C. LEAD LOADER

The development phase is completed and the copper threading technique is designated as an approved method. The washer pressing development has been proven to be unreliable, however, a survey of intermediate adherence materials is in process to fully explore this concept. The design of final equipment is 20% complete.

V. PROGRAM FOR NEXT INTERVAL

It is anticipated that the design phase of all tasks will be completed and the construction phase will have progressed to the following degree:

A. Grid Lathe - 40%

B. Exhaust Machine - 80%

C. Lead Loader - 30%

VI. PUBLICATIONS AND REPORTS

Monthly Letter Report No. 3
for period of 1 August 1962 to 31 August 1962

Monthly Letter Report No. 4
for period of 1 September 1962 to 30 September 1962

Monthly Letter Report No. 5
for period of 1 October 1962 to 31 October 1962

VII. IDENTIFICATION OF TECHNICIANS

A. MANPOWER EFFORT DURING SECOND QUARTER

1. Technical

G. Lalak	-	416 hours
C. Lindsley	-	243 hours
G. Shaffer	-	51 hours
M. Tuttle	-	192 hours
H. Waltke	-	8 hours

2. Semi-Technical

F. Hoth	-	123 hours
W. Kilroy	-	12 hours
V. Riggi	-	47 hours
B. Sherman	-	194 hours
G. Simmons	-	492 hours
C. Trushell	-	14 hours

B. PERSONNEL BIBLIOGRAPHIES (Personnel added during second Quarter)

F. Hoth

Mr. Hoth is presently attending Fairleigh Dickinson University where he is taking courses leading to a B.S. in E E. Prior to this, Mr. Hoth completed an eight month course in Radio at Melville Radio Institute in New York City and an eight month course in Television in Brooklyn, New York. He has been employed by RCA for 11½ years. For 11 years he worked as a production electrician, and for the past six months he has worked as an electrical draftsman.

W. Kilroy

Mr. Kilroy is presently attending the Special Courses Division at Newark College of Engineering where he expects to complete the three year course in Electrical Technology shortly.

B. PERSONNEL BIBLIOGRAPHIES (CONT'D)

W. Kilroy (Cont'd)

Prior to this he completed a seven month course in Principles of Electronics at the Electrical Musical Industries College in London, England. At home Mr. Kilroy maintains a well equipped electronics laboratory where he pursues his hobbies such as designing his own electronic organ. Prior to joining RCA he had worked for 10 years as an electrician. In October 1962 he came to RCA as an electrical technician.

B. Sherman

Mr. Sherman joined RCA in September, 1962 as a Machine Designer. Prior to this association, he was engaged in the design of various equipment with several industries, ranging from electronics to press manufacturers. He attended the Aviation Trades High School of New York and evening courses in engineering at Pratt Institute. He is presently applying to Newark College of Engineering for admission to the Evening Division, with the intent of obtaining a degree in Mechanical Engineering.

C. Trushell

Mr. Trushell has over 26 years of experience entirely devoted to working with electronic equipment. He has taken two years of correspondence courses with National Radio Institutes. At home Mr. Trushell has a well equipped laboratory of his own which he uses to carry on electronic projects of his own, such as designing his own HI-FI equipment. He has been employed by RCA for over 16 years working successively as a production electrician, foreman in our electrical equipment production shop and as an electrical equipment designer.

B. PERSONNEL BIBLIOGRAPHIES (CONT'D)

H. C. Waltke

Mr. Waltke received his Bachelor of Science degree in Electrical Engineering from the Newark College of Engineering in 1950, and his Master of Science degree in Electrical Engineering from Columbia University in 1955. He has 12 years experience in electrical machine design, and holds two patents. Mr. Waltke has been with RCA since 1952 as a design and development engineer in the Receiving Tube Equipment Development Section. He made significant contributions to the development of RCA mechanized testing equipment. In 1961, Mr. Waltke became an electrical engineering project leader in the Equipment Development Section, which position he now holds. For the past six years, he has been an instructor at the Newark College of Engineering (evening special courses division). He is an active member of the IRE.